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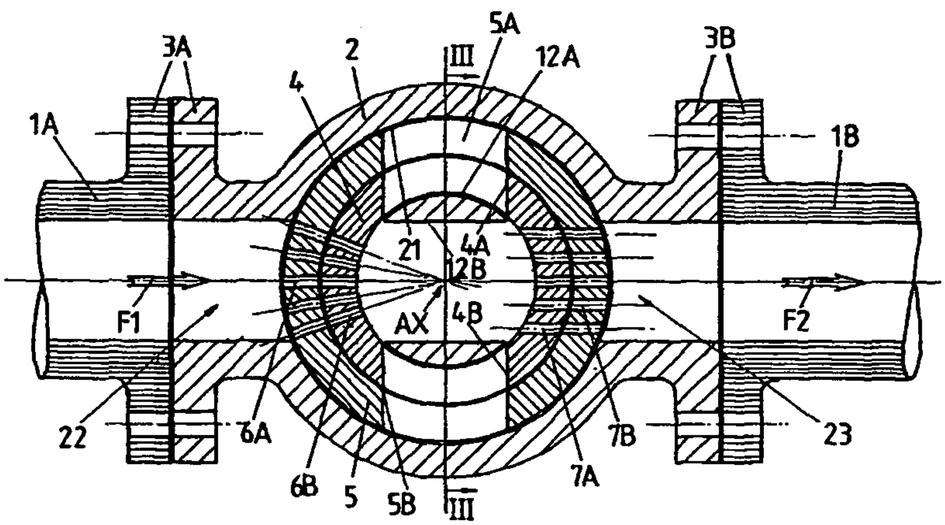

(57) Abstract

Mixer for mixing a fluid flow in a pipe connection, in particular a multiphase flow, comprising a housing (2) to be inserted in the pipe connection (1A, 1B) and to have the fluid flow (F1, F2) passing through it, whereby the housing comprises inlet and outlet openings (22, 23) respectively. In the housing (2) there are provided one, two or more adjoining and individually displaceable regulating elements (4, 5) having cooperating wall portions at least at a downstream side of the housing (2). In the cooperating wall portions there is provided a number of through-going flow channels (7A, 7B) which can be regulated, and control of the flow channels is adapted to take place by movement of the regulating elements (4, 5).

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Apparatus for mixing the components of a fluid flow

This invention relates to a mixer for mixing the components of a fluid flow in a pipe connection, in particular a multi-phase flow as e.g. fluids produced from an oil or gas well, comprising a housing adapted to be inserted in the pipe connection and to have the fluid flow running therethrough, whereby the housing comprises an inlet and and an outlet opening respectively.

The invention has primarily been developed in connection with measurement of multi-phase mass flow, whereby the components can be e.g. oil, water and gas. By multi-phase flow there is here also ment cases in which only two phases are concerned, e.g. a liquid and a gas, or even when there is question of two liquids in one phase being conducted through the same pipe or the like. It will be realized however, that the mixer to be described in the following description, may also have other practical uses than in connection with mass flow measurement. Moreover when pipe connections are referred to here, this comprises both quite regular pipes connected to the input and output sides respectively of the mixer, and pipes or connections that can be more or less integrated into other equipment or devices, e.g. valves, pumps and so forth.

A mixer as stated in the introductory paragraph above, according to this invention has novel a specific features consisting in the first place therein that in the housing there is provided at least one moveable regulating element with wall portions associated with at least a downstream side of the housing and provided with a number of through-going flow channels, each of which has a substantially smaller cross-sectional area than the flow cross-sectional area at the inlet and outlet opening respectively, and that the regulating element is adapted to be moved in relation to the housing.

According to the fundamental solution stated above, the invention makes possible two main aspects, of which one aspect in the principle is bases on a rotational symmetry and mutual displacement of the regulating elements primarily by a

r tary movement thereof. Anoth r main asp ct is directed to a basic planar arrangement of one or more regulating elements, whereby said movement thereof takes place by translational movement. The invention also comprises a measurement apparatus for mass flow as mentioned above, and the apparatus is based on a combination with the mixer described. A particular embodiment of the mixer according to the invention is intended for use in a freezing plant, heat pump system or the like as a gas-liquid distributor in association with an evaporator.

In the claims there are also recited additional novel and specific features related to both the mixer and the measurement apparatus.

The mixer according to the invention involves advantages inter alia by making possible control, either discretely by using only one or possibly several regulating elements, or continuously so that at any time it can be adjusted to the most favourable regulating positon, with a resulting favourable degree of opening. This means that the no-slip condition to a highest possible degree can be fulfilled over a wide range of flow velocities. According to an embodiment the mixer can be set in a particular position (pigging position) that makes it possible to run a pipe pig therethrough. Moreover the mixer can be so designed that it is possible to mount it at any orientation being convenient in practice.

In the following description the invention shall be explained more closely with reference to the drawings, in which:

Fig. 1 shows an example of a first embodiment of the mixer according to the invention, as seen in axial longitudinal section normally to a common axis of rotation in the mixer,

fig. 2 shows the exemplary embodiment in fig. 1, here als in axial longitudinal section, but coincident with said common axis of rotation,

fig. 3 shows a cross section of the mixer in fig. 1 through the common axis of rotation, and

fig. 4 somewhat simplified shows a second embodiment of the mixer according to the invention in l ngi-

tudinal section through a p rti n of a housing with two regulating elements therein,

fig. 5 shows a longitudinal section as in fig. 3, but normally to the plane of section in fig. 4,

fig. 6 shows an enlarged detail of the longitudinal section in fig. 4, with the two regulating elements in a mutual position giving a maximum opening of the flow channels,

fig. 7 in a sectional view as in fig. 3 shows a particular embodiment for employment in freezing plants, heat pump systems or the like,

fig. 8 shows a modification of the embodiment of fig. 1 and 2,

fig. 9 shows another modification of the embodiment of fig. 1 and 2, and

fig. 10 shows a third modification of the embodiment of fig. 1 and 2.

In fig. 1 and 2 of the drawings the pipe connection or main pipe concerned is represented by two pipe pieces 1A and 1B, which by means of flange connections 3A and 3B respectively, are connected to a housing 2 for the mixer, whereby the direction of fluid flow through the mixer is indicated with arrows F1 and F2 in fig. 1. The housing 2 has an interior wall 21 that is substantially sylindrical and is broken by an inlet opening 22 and an outlet opening 23 respectively, which in turn are leading directly to the respective flange connections 3A and 3B.

In the housing 2 there are provided two regulating elements 4 and 5 which are co-axial and both have a sylindrical shape as the housing 2. These regulating elements 4 and 5 are individually rotatable in housing 2 and at the sylindrical casing or wall portions have perforations in the form of through-going flow channels upstream as shown at 6A and 6B, and downstream as shown at 7A and 7B. Between the inner wall 21 in housing 2 and the outside of one regulating element 5, and moreover between the inside of element 5 and the second regulating element 4, there are provided seals for the required fluid sealing. The common axis AX of housing 2 and the pair of regulating lem nts 4 and 5, in this example is

oriented at a right angle to the general through-flow direction of the multi-phase flow, i.e. the longitudinal axis in fig. 1 and 2. Embodiments may be contemplated however, wherein the common rotational AX and the longitudinal axis F1-F2 are not exactly normal to each other, but in all cases the common axis will lie broadly transversally to the longitudinal axis.

As to the shape of the regulating elements these need not be fully circular sylindrical as illustrated in the drawings, but can e.g. also be spherical, i.e. in principle the elements are in the form of rotational bodies. The casing or wall portions being provided with the flow channels 6A,B, 7A,B as referred to, are shown with a comparatively large wall thickness, which can be considered in relation to the flow channels, which preferably should have a substantially larger length than lateral dimensions.

At the upstream side the input flow channels 6A and 6B at the wall portions facing each other on the regulating elements 5 and 4, respectively, have a convergent orientation, so that they have a direction generally towards a central region within housing 2, a concentrated converging point being indicated exactly at the intersection between the common axis AX and the longitudinal axis F1-F2. This is to be considered as a more or less idealized case. At the other or downstream side the outgoing flow channels 7A and 7B are shown with a parallel orientation corresponding to the through-flow direction or longitudinal axis F1-F2. At this point it is remarked that by displacing the two regulating elements 4 and 5 from the rotary position they have according to the drawings, the configuration and orientation of the respective flow channels will of course be changed. In the rotary position shown in the drawings the flow channels both upstream and downstream are at one hand aligned with each other and on the other hand centered with respect to openings 22 and 23, so that the fluid through-flow can take place with the least possible flow resistance. Thus the drawings show the mixer in a fully open position, where the channels constitut a continu us and edg -free fl w path through the casing r wall porti ns of the regulating elements. If the

mixing effect aimed at is not obtained with this configuration, one or both regulating elements must be rotated so that the degrees of opening between the elements will be smaller. This results in a higher fluid velocity and a better fluid mixing in the passage between the elements, but also a higher flow resistance (pressure drop).

As will be seen from fig. 3 the flow channels in this example, e.g. channels 7A, are designed with a circular cross section. According to fig. 1 and 2 the cross section is the same throughout the whole length of each channel. However there are many possibilities of variation as regards the design of the flow channels, whereby one possibility is that these can have a more flattened or slit like cross-sectional shape, such as with the largest lateral extension in the circumferential direction of the wall portions of the regulating elements. Further the channels can be designed with a certain conicity in the longitudinal direction (see fig. 10), perhaps in particular with a certain nozzle effect at the outlet ends towards the central space in housing 2, and towards the outlet opening 23 respectively from the housing. The flow channels 6A, 6B, 7A and 7B shown, have an approximate regular distribution over the total flow cross section of openings 22 and 23 as well as the adjoining pipe pieces or connections 1A and 1B, and such a regular distribution is considered to be the most favourable arrangement. This in particular applies to the output flow channels 7A and 7B. Under special circumstances however, it can be convenient to deviate from the regular distribution, in particular at the upstream side of the mixer. There is also a reason to note that each of the flow channels described, has a cross-sectional area being substantially smaller than the total cross-sectional area referred to with respect to openings 22 and 23. For the purpose of obtaining a larger capacity, i.e. a smaller flow resistance through the mixer, housing 2 can be designed with an expanded flow cross section towards one or both openings 22 and 23, so that the respective wall portions perforated with channels in each of the two regulating elements 4 and 5, could be enlarged correspondingly in area.

Still another possibility with respect to the shape of the flow channels consists therein that these can have unequal cross sections in the two cooperating regulating elements. Fig. 9 shows this modified embodiment, which corresponds to fig. 1 except for the outer regulating element 5C having flow channels 6C and 7C with expanded cross sections, which means that they have larger cross sections than cooperating channels in the inner, adjacent regulating element 4. This involves inter alia, a regulating position for large flow velocities, where the regulating element 5C with the largest flow cross section is set in an operative position, i.e. mixing position, whereas the other regulating element 4 is set in its pigging position, i.e. with its large bore (to be described below) in the through-running position. At low flow velocities the regulation can be the opposite, i.e. with the narrower flow channels in mixing position and the larger flow channels rotated into an inoperative position. These variants and regulating positions show that the mixer can be designed with only one regulating element, e.g. provided thereby that the regulating elements 4 and 5 in fig. 1-3 are integrated into one single element.

From fig. 2 and 3 it is seen that the regulating element 4 has a spindle 14 and the regulating element 5 has a tubular spindle 15 being co-axial to spindle 14, so that rotation of the regulating elements mutually and with respect to housing 2 can be effected. In the simplest case the rotation can take place by means of manually operated controls, or possibly by means of drive devices such as actuators or the like, as being known e.g. in connection with valve operations. Spindles 14 and 15 are taken out through a top cover 2A on housing 2.

With the structure described the degree of opening of the mixer can be controlled by rotating the inner regulating element 4 in relation to the outer regulating element 5, so that the flow channels through the wall portions of the elements are displaced with respect to each other. As a result there will be a larger or smaller narrowing of the flow cross-sectional area at the wall portions facing each other, i.e. at the interface between the two regulating

lements, depending on the r lative rotational position established. At a sufficiently large mutual rotation of the regulating elements, the passage through the flow channels will be completely closed.

In addition to the above mentioned, relatively narrow through-flow channels the two regulating elements 4 and 5 have bores 4A, 4B and 5A, 5B respectively, of diameter corresponding to the pipe diameter and the openings 22 and 23. These bores have an axis lying generally at a right angle to the central axis of the respective wall portions with the flow channels. Thus, when the mixing function referred to shall not be established, i.e. with the mixer in the angular position as shown in the drawings, both regulating elements 4 and 5 in common can be rotated to a position in which the bores 4A, 4B, 5A, 5B coincide with openings 22 and 23. This leads to a substantially free and straight pipe section which inter alia makes it possible to run a pipe pig through the housing. For obtaining such a smooth through passage the housing 2 is provided with a plug-like core member 12, which can be adapted to sealingly cooperate with the internal side of regulating element 4 i.e. at the sylindrical outer wall 12A of the core member. Through the core member there is shown a bore 12B lying preferably aligned with and provided with the same flow cross section as the inlet opening 22 and the outlet opening 23.

The function of the mixer as described thus far, has to a large extent appeared from the preceding description, but at this point the following is additionally remarked: The forms of flow to be handled by the mixer can be rather arbitrary and varying, since there may be the question of laminar flow, plug flow, annular flow or dispersed flow, bubble flow or so-called churn flow. With some types of multi-phase flow a liquid component in particular will be located at the bottom of the input pipe 1A, whereas other components fill the remaining part of the flow cross section. The convergent orientation of the input flow channels 6A-6B as described, in such a situation will contribute to lifting the liquid component from the bottom of the pipe upwards, wher as gas or similar fluid components being l cated in the

high r cross-sectional portions of pipe 1A and inlet opening 22, will be urged down towards the central region of the housing, i.e. within the bore 12B. This causes e.g. the two phases gas and liquid in such an incomming multi-phase flow to be spread over the flow cross section at the same time as an effective mixing takes place in the central region mentioned above. The liquid-gas mixture is further pressed out through the parallel outgoing flow channels 7A-7B at the downstream side of the mixer, which leads to a further homogenizing of the fluid components over the full flow cross section. Thus from the outgoing flow channels in this example, there will be discharged a mixture in which the liquid phase or phases are finely distributed in the gas, or depending on the proportion of gas fraction, the gas is finely distributed in the liquid or liquid mixture.

At the downstream side and in the pipe piece 1B connected to the mixer, there will accordingly be a flow in which the fluids are very well mixed and where the local gas fraction is approximately the same over the whole pipe cross section. Besides the two or three phases being present will have average velocities being very close to each other, i.e. near the no-slip condition. Adjustment of the degree of opening in the mixer by rotating the two regulating elements 4 and 5 in relation to each other, makes it possible to optimize the flow pattern so that the no-slip condition between liquid and gas will be fulfilled to a highest possible degree.

For the purpose of the primary use of the mixer described above, in connection with mass flow measurement as mentioned previously, there is in fig. 2 at 30 indicated a radial plane downstream of the actual outlet opening 23 (and the mouth of the flow channels 7B), where a fraction gauge can be adapted to sense the magnitude or parameter of interest. The phase fractions may also be determined by measurement locally within the flow channels in the outer regulating element 5. At the location or the plane indicated at 30 the condition of equal velocity of the discharged liquid and gas will be best fulfilled under many circumstances. E.g. the fraction gauge can be a multi-en rgy gamma densit meter that

m asur s the fractions of each indivudual fluid phase being present in the outgoing multi-phase flow.

Moreover in fig. 2 there is shown a differential pressure sensor 9 being adapted to measure the pressure drop ΔP_m across the mixer, i.e. with a connection 9A to the inlet at flanges 3A or opening 22 and a connection 9B to the outlet at flanges 3B or opening 23. A more preferred upstream connection 9C instead of 9A is shown however, centrally within housing 2. Accordingly pressure sensor 9 will perform a differential pressure measurement over the outlet of the mixer and not over this as a whole. In this section or part of the mixer the fluids are well mixed and the no-slip condition is substantially fulfilled. The most substantial portion of the pressure drop measured, will of course be present between the upstream side of channels 7A and the downstream side of channels 7B. The friction contribution of this pressure drop is proportional to the average density ρ_m of the fluid mixture and to the square of the velocity U_m of the mixture. By adjustment of the relative rotational position or angle between the two regulating elements 4 and 5, the pressure drop over the whole mixer is controlled, and simultaneously the flow conditions are changed so that the most favourable flow conditions at any time are obtained.

The average density is given by the densities and area fractions of the fluids. This together with the pressure drop measurement in unit 9 gives the velocity of the mixture. The mass flow of each indivual fluid component then is found as the product of the fluid density, area fraction, pipe cross section and common velocity. This determination and calculation of mass flow is based upon principles being known per se, but anyhow shall be explained somewhat more in detail below.

Mass flow (in kg/s) of phase no. i is given by:

$$M_i = p_i A_i U_m \qquad (1)$$

whereby

ρ_i = density of fluid no. i (kg/m^3),

A_i = cross-sectional area of fluid no. i and

U_m = the average vel city (m/s) f the mixtur .

In rder t be able to employ the mixer described above, for measuring mass flow in multi-phase flow, the mixer must be used in combinati n with a fraction gauge. By means of a fraction gauge it is possible to determine the fractions of each individual fluid, i.e.

$$\gamma_i = A_i/A \tag{2}$$

Here A_i is the area being covered by fluid no. i, and

$$A=\sum_i A_i \tag{3}$$

is equal to the pipe cross section.

The fraction gauge is to be positioned where the fluids are well mixed. This can be at the downstream transition between regulating elements 4 and 5, within one of elements 4 and 5, or immediately downstream of the outlet opening, e.g. at 30 in fig. 2 as mentioned above.

Such a fraction gauge for oil and water can e.g. be a multi energy gamma-densitometer (having two energy levels, where the decay coefficient of the gamma rays is different for oil and water with respect to at least one energy level) or a single energy gamma-densitometer in combination with an impedance gauge.

The friction contribution of this differential pressure, as calculated from measurement with unit 9 and with compensation for static pressure drop (the gravitation contribution), is proportional to the average density of the mixture and the square of the velocity of the mixture:

$$\frac{1}{2}\rho_m U_m^2 = k(d, Re)\Delta P_m \tag{4}$$

s that the average velocity of the mixture will be

$$U_m=\sqrt{2\cdot k(\mathring{a},Re)\cdot\Delta P_m/\rho_m} \qquad (5)$$

ρ_m = the average density (kg/m^3) of the mixture
ΔP_m = the differential pressure over the mixer (Pa)
å = the degree of opening = the lumen of (?) the channels /maximum lumen
Re = Reynolds number, being representative of the channels giving the largest contribution to the differential pressure measured,
k(å,Re) = a factor being calibrated against the degree of opening and Reynolds number,

The average density of the mixture

$$\rho_m=\sum_i \gamma_i\rho_i \qquad (6)$$

where
ρ_m = density of fluid no. i and
γ_i = the area fraction of fluid no. i (given by equation 2).

It is obvious that the choice of measuring device for the fraction measurements and the actual arrangement of such a gauge in association with the outlet from hosing 2, can be varied in many ways in relation to what is described and illustrated here. If e.g. a two phase flow is concerned, the fraction gauge can be an electrical capacitance element instead of being a gamma-densitometer. The postion of the measuring device can be relatively close to the outlet opening 23, as indicated as 30, or the distance from the opening can be larger than illustrated in fig. 2, e.g. with a distance corresponding to several interior diameters of the following pipe 1B. On the other hand cases may also be contemplated where a favourable positi n f the measuring device

is at a radial section or plane through the outgoing flow channels 7B. Still another possibility is to have such measuring devices located at two or more positions within the range of distances mentioned here, so that a measuring device for the measurement or the measuring situation, can be selected by the operator.

In the case of a single phase flow where the density and viscosity of the fluid are known, velocity measurement can be performed directly according to equation (5) above, without the fraction measurement described.

In the embodiment shown in fig. 1-3 there are described flow channels both upstream and downstream of the regulating elements 4 and 5. For some applications it may be sufficient to arrange pairs of cooperating flow channels 7A and 7B only at the outlet or downstream side, whereas the two regulating elements 4 and 5 at the upstream side must then be provided with large through flow openings corresponding approximately to the flow cross section of inlet opening 22, i.e. also corresponding to the lateral bores 4A, 4B and 5A, 5B respectively in both regulating elements, as described above. As an alternative flow channels at the inlet side can be provided only in one of the two regulating elements.

Another possible modification is to provide more than two co-axial regulating elements, such as a third and perhaps quite thin walled regulating element between the two elements being described and shown in the first embodiment of fig. 1-3 of the drawings.

Whereas the embodiment described above is based on rotational symmetry, the embodiment of fig. 4-6 in principle is a planar arrangement of the regulating elements. In fig. 4 only the downstream portion is shown of a housing 12 with two cooperating regulating elements 14 and 15, and a following outlet opening 33 that can e.g. be coupled to a pipe connection in a similar manner as outlet opening 23 in fig. 1. Arrow F4 in fig. 4 shows the direction of through flow.

At the top of the two (cut off) regulating elements 14 and 15 there are arrows showing the possibilities of desplacing these elements. Thus elements 14 and 15 are arranged to be m veable in slits 13 in housing 12. S e also fig. 5.

Through regulating elements 14 and 15 there are provided a number of flow channels, of which one such channel 17 is indicated in fig. 4, 5 and 6.

While the plate-like regulating element 15 is relatively thick, it is preferred that the cooperating element 14 is relatively thin, whereby the length of the individual flow channels 17 are determined substantially by the thickness of element 15. In the embodiment shown here the flow cross-sectional area of each channel 17 is adapted to be controlled simultaneously along the whole length of the channel. This is obtained by means of a tongue-like plate piece 14B which protrudes from the regulating element 14 into each channel 17 and forms one of the boundary surfaces thereof. In this connection it will be realized that each flow channel 17 most conveniently has a rectangular cross-sectional shape, so that a sufficiently good seal between the side edges of tongue piece 14B and the adjoining channel walls is obtained. Fig. 4 shows elements 14 and 15 in a mutual position where somewhat more than half of the maximum cross-sectional area of each channel 17 is open for fluid flow. Fig. 6 shows the maximum open position of elements 14 and 15, where tongue piece 14B with its inner side (upper side) is brought into engagement with one (upper) wall of the opening in element 15, which initially forms the flow channel 17.

In a complete mixer according to the invention a mixing chamber in housing 12 (at the right hand side of elements 14 and 15 in fig. 4) normally will also have a further, corresponding set of regulating elements at the upstream or inlet side (not shown) in full analogy to the first and circular embodiment of figs. 1-3. As the first embodiment also the one in fig. 4 has large bores 14A and 15A which upon appropriate displacement of elements 14 and 15 can be brought in line with the outlet opening 33, in particular for the purpose of pigging, as also explained in connection with the first embodiment above. For maximum opening in that case, elements 14 and 15 ought to be mutually displaced to a maximum open position as shown in fig. 6, so that bores 14A and 15A will be compl tely aligned with each other. In contrast to the embodiment of figs. 1-3 the four regulating elements

in such a mixer can be displaced and adjusted individually and independently of each other. In certain circumstances this can be an advantage.

Although the plate- or slide-like regulating elements 14 and 15 have been referred to as planar, the fundamental manner of function will still be the same if they were designed with a certain curvature, i.e. preferably with a curvature in the plane corresponding to the section of fig. 5. The mutual displacement of elements 14 and 15 by translational movement, will be possible also in the latter case.

It will also be possible to modify the embodiment of figs. 1-3 so that this by translational movement, i.e. parallel to the axis AX, can provide for regulation of flow channels 6A-6B and 7A-7B respectively. For obtaining the pigging position, however, a rotary movement must be effected as explained previously. This modification can be seen from fig. 8, where the whole design corresponds to fig. 1 except for the inner regulating element 4X. This element is designed so as to make possible a certain axial translational movement, as illustrated with arrow BX.

Finally, it will be realized that the flow channels both in the first embodiment in figs. 1-3 and in the second embodiment of figs. 4-6, can be designed with a varying cross-sectional area, possibly cross-sectional shape, along its whole length or parts thereof. Thus, in fig. 10 there is shown a modified outer regulating element 5D having conically narrowing channels 6D upstream and conically expanding channels 7D downstream. In other respects this embodiments correspond to the one in figs. 1 and 2. Moreover, the downstream portion of such flow channels can be provided with nozzle-like restrictions. Still another modification of the embodiment of figs. 1-3 and fig. 10 consists in the variation of the flow cross-section along the whole length of the channels, by means of tongue-like plate pieces at one regulating element, as described for the embodiment of figs. 4-6. Such a modification of the first embodiment can also be implemented on the basis of a mutual r tation of the two regulating elements for adjustment of the flow conditions.

In the modified embodiment of fig. 7, which is intended for use as a gas-liquid distributor in a freezing plant or heat pump system, the outlet comprises a number of outlet channels 34A, 34B, 34C to be lead to an evaporator with several inlets. These inlets correspond to the number of separate outlet channels 34A-C. There is here the question of a specific channel or pipe branching for the purpose of connection to respective evaporator inlets.

C l a i m s

1. Mixer for mixing the components of a fluid flow in a pipe connection, in particular a multi-phase flow such as fluids produced from an oil or gas well, comprising a housing (2,12) adapted to be inserted in the pipe connection (1A,1B) and to have the fluid flow (F1,F2,F4) pass therethrough, said housing comprising an inlet and and outlet opening (22,23,33) respectively,
c h a r a c t e r i z e d i n that the housing (2,12) is provided with at least one moveable regulating element (4,5,14,15) having wall portions associated with at least a downstream side of said housing (2,12) and provided with a number of through-going flow channels (7A,7B,17), each having a substantially smaller cross-sectional area than the flow cross-section of the inlet and outlet openings (22,23,33) respectively, and that the regulating element (4,5,14,15) is adapted to be moveable in relation to said housing.

2. Mixer according to claim 1,
c h a r a c t e r i z e d i n that two or more regulating elements (4,5,14,15) comprising said cooperating wall portions, are individually and mutually displaceable, with resulting flow channels (7A,7B,17) being able to be regulated.

3. Mixer according to claim 1 or 2,
c h a r a c t e r i z e d i n
- that said housing (2) internally has walls (21) being t a substantial extent rotational surfaces and being broken by said inlet and outlet openings (22,23) respectively,
- that in said housing (2) there is provided at least one co-axial and rotatable regulating element (4,5) having the general shape of a rotational body,
- that said housing with said regulating element has a common axis (AX) being oriented laterally in relation to a general through-flow direction (F1,F2) of fluid flow from said inlet to said outlet opening (22,23),

- that said wall portions of each regulating element (4,5) is provided with a number of substantially radial, outgoing flow channels (7A,7B) and
- that said wall portions with outgoing flow channels (7A,7B) are adapted to assume a position in which they face the outlet opening (23).

4. Mixer according to claim 3, c h a r a c t e r i z e d i n that two or more regulating elements (4,5) partially enclose each other, that mutually facing wall portions with said flow channels (7A,7B) have a mutual fluid sealing and that said regulating elements are adapted to assume a position in which all or some of the outgoing flow channels (7B) in one regulating element (5) are aligned with flow channels (7A) in another regulating element (4).

5. Mixer according to any one of claims 1-4, c h a r a c t e r i z e d i n that at least two regulating elements (4,5) are individually rotatable for said mutual displacement of the regulating elements (4,5).

6. Mixer according to any one of claims 1-4, c h a r a c t e r i z e d i n that said regulating elements (4X,5) are mutually moveable in an axial direction for said mutual displacement of the regulating elements.

7. Mixer according to claim 1 or 2, c h a r a c t e r i z e d i n that said displaceable regulating elements (14,15) have a plate- or slide-like shape and are adapted to be displaced mutually by translational movement.

8. Mixer according to claim 7, c h a r a c t e r i z e d i n the provision of two adjacent (upstream) regulating elements in association with said inlet opening and two adjacent (downstream) regulating elements (14,15) associated with the utl t opening (33), and that

each regulating elem nt preferably is individually adjustable.

9. Mixer according to any one of claims 1-8, c h a r a c t e r i z e d i n that each regulating element (4,5,14,15) also is provided with a through-bore (4A,4B,5A,5B,14A,15A) of dimensions preferably corresponding substantially to the inlet and outlet openings (22,23,33) respectively, for a substantially free through-flow without mixing effect when the regulating element (4,5,14,15) concerned, is set in a position where the radial bore or bores (4A,B,5A,B,14A,15A) are aligned with said inlet and outlet openings (22,23,33) respectively.

10. Mixer according to claim 3 or 4 and 9, c h a r a c t e r i z e d i n that said bore (4A,4B,5A,5B) is provided in each regulating element (4,5) at mutually diametrically opposite wall portions being in principle angularly spaced by approximately 90°, about the common axis (AX) from said wall portions having flow channels (7A,7B).

11. Mixer according to any one of claims 3-6 or 9-10, c h a r a c t e r i z e d i n that said housing (2) interiorly and partially enclosed by the other regulating element (4), comprises a central core member (12) having a through-bore (12B) aligned with and designed with substantially the same flow cross-section as the inlet and outlet openings (22,23) respectively.

12. Mixer according to any one of claims 3-6 or 9-10, c h a r a c t e r i z e d i n that one (5) and/or the other (4) regulating element at a (upstream) wall portion substantially diametrically opposite of said (downstream) wall portions having the outgoing flow channels (7A,7B), is provided with a number of generally radial, ingoing flow channels (6B,6A) each having a cross-sectional area being substantially smaller than the flow cross-section of the inlet and utlet op nings (22,23) respectively.

13. Mixer according to claim 12, in which each regulating element (4,5) is provided with ingoing flow channels (6B,6A), characterized in that all or some of the ingoing flow channels (6A) in one regulating element (5) is adapted to be aligned with flow channels (6B) in the other regulating element (4), in one angular position.

14. Mixer according to claim 13, characterized in that all or some of the flow channels (6D,7D) in one regulating element (5D) have a larger cross-sectional area than all or some of corresponding flow channels (6B,7A) in an adjoining regulating element (4).

15. Mixer according to claim 11, 12 or 14, characterized in that said ingoing flow channels (6A,6B) are convergently oriented towards a central region within said housing (2).

16. Mixer according to any one of claims 1-15, characterized in that said outgoing flow channels (7A,7B,17) are arranged substantially in parallel t each other and are preferably regularly distributed over said wall portions.

17. Mixer according to any one of claims 12-16, characterized in that the total flow-through area of all flow channels (6A,6B,7A,7B,17) is substantially the same at all said wall portions.

18. Mixer according to any one of claims 3-6 or 9-17, characterized in that said regulating elements (4,5) are each provided with its rotating spindle (14,15) being extended co-axially to the same side of said housing (2).

19. Mixer according to any one of claims 1-18, characterized in that said displacement of the regulating elements (14,15) is adapted to regulate the inter-

nal cross-section of said flow channels (17) along a substantial portion of the length of the channels.

20. Mixer according to claim 19,
c h a r a c t e r i z e d i n that one regulating element (14) is relatively thin and is provided with tongue-like plate pieces (14B) protruding into and forming a longitudinal boundary surface through substantially the whole length of cooperating flow channels (17) in the other regulating element (15), and that said flow channels (17) preferably have a rectangular cross-sectional shape.

21. Mixer according to any one of claims 1-20,
c h a r a c t e r i z e d i n that at least some of said flow channels (6C,7C) have varying cross-sectional areas, possibly cross-sectional shape along the whole length or portions of the length.

22. Mixer according to any one of the preceding claims, for use in a freezing plant, heat pump system or the like where an evaporator with several inlets is incorporated,
c h a r a c t e r i z e d i n that said outlet opening is subdivided into and continues as a number of outlet channels (34A,B,C) corresponding to said several inlets to the evaporator.

23. Measuring apparatus for mass flow in a mixture of components of a fluid flow in a pipe connection, such as fluids produced from an oil or gas well,
c h a r a c t e r i z e d by the combination of a mixer according to any one of the preceding claims, and a differential pressure sensor (9) for measuring the pressure drop completely or partially over said housing (2), for use in calculating the mass flow.

24. Apparatus according to claim 23,
c h a r a c t e r i z e d i n that said differential pressure sensor (9) is adapted to measure the pressure drop

between a central point (AX/BX) inside said housing (2) and a point at said outlet opening (23).

25. Apparatus according to claim 23, whereby said fluid flow is a multi-phase flow,
c h a r a c t e r i z e d in that a fraction measuring device is arranged in association with said outlet opening (23).

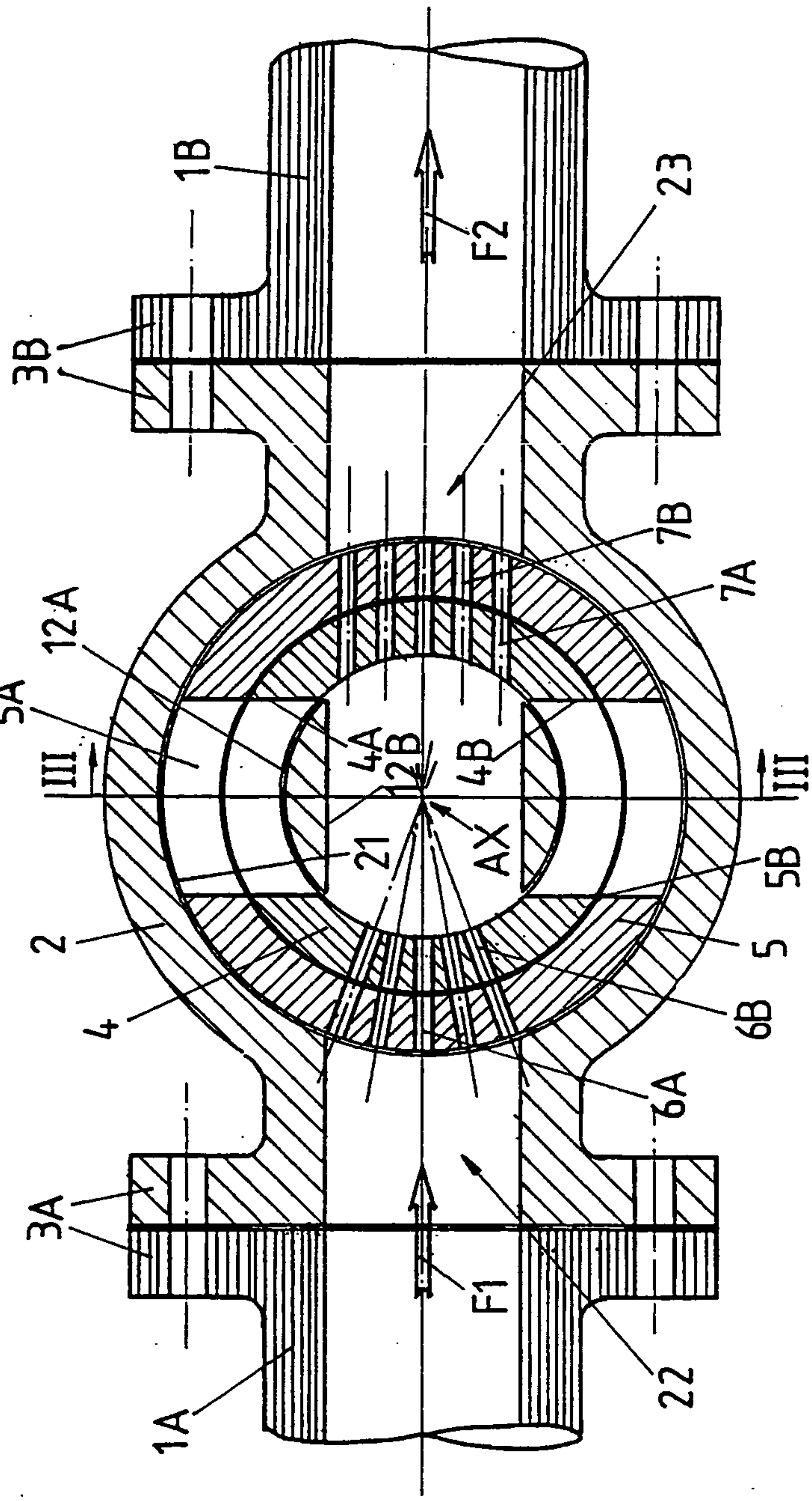

Fig. 1

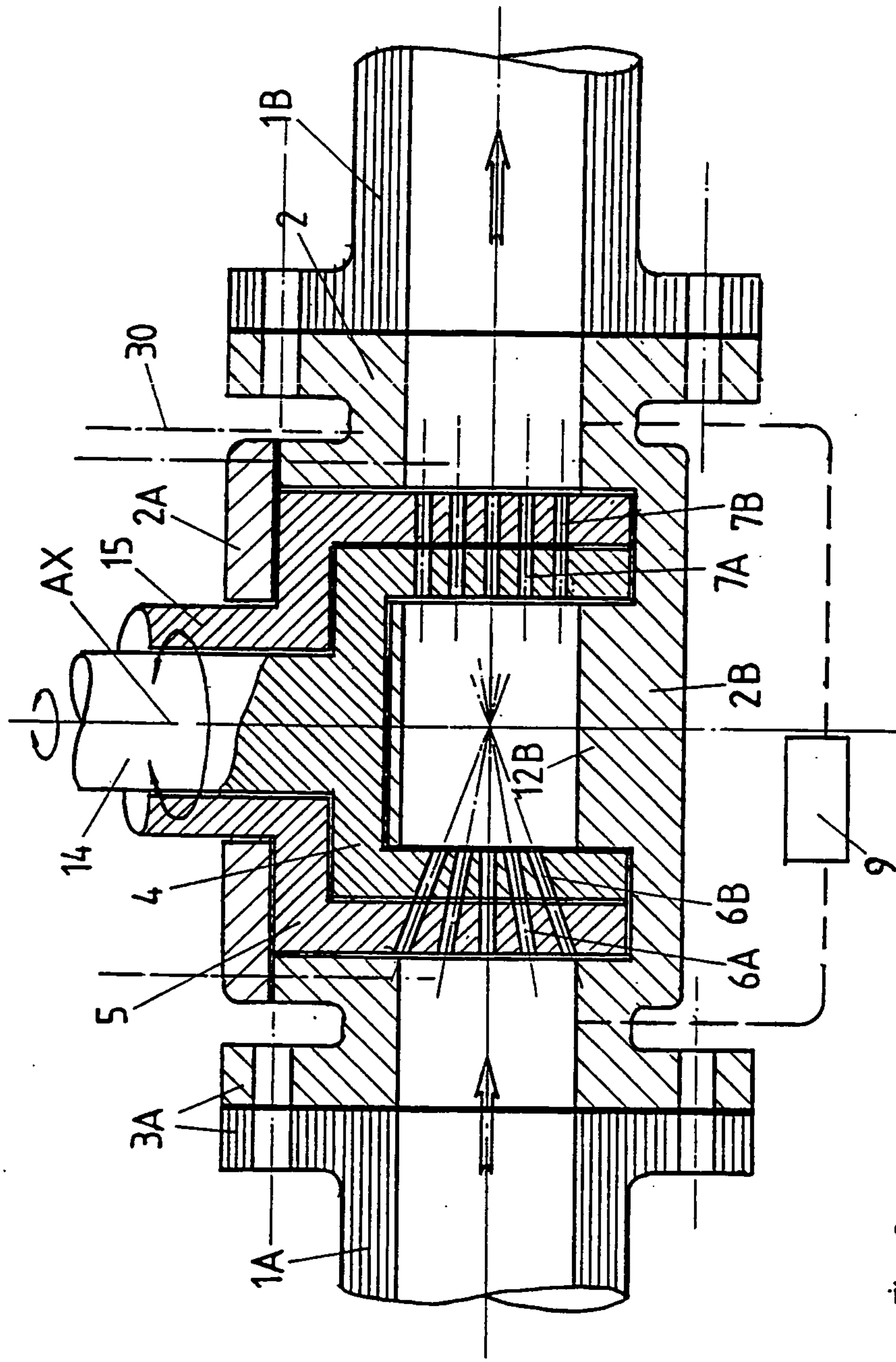

Fig. 2

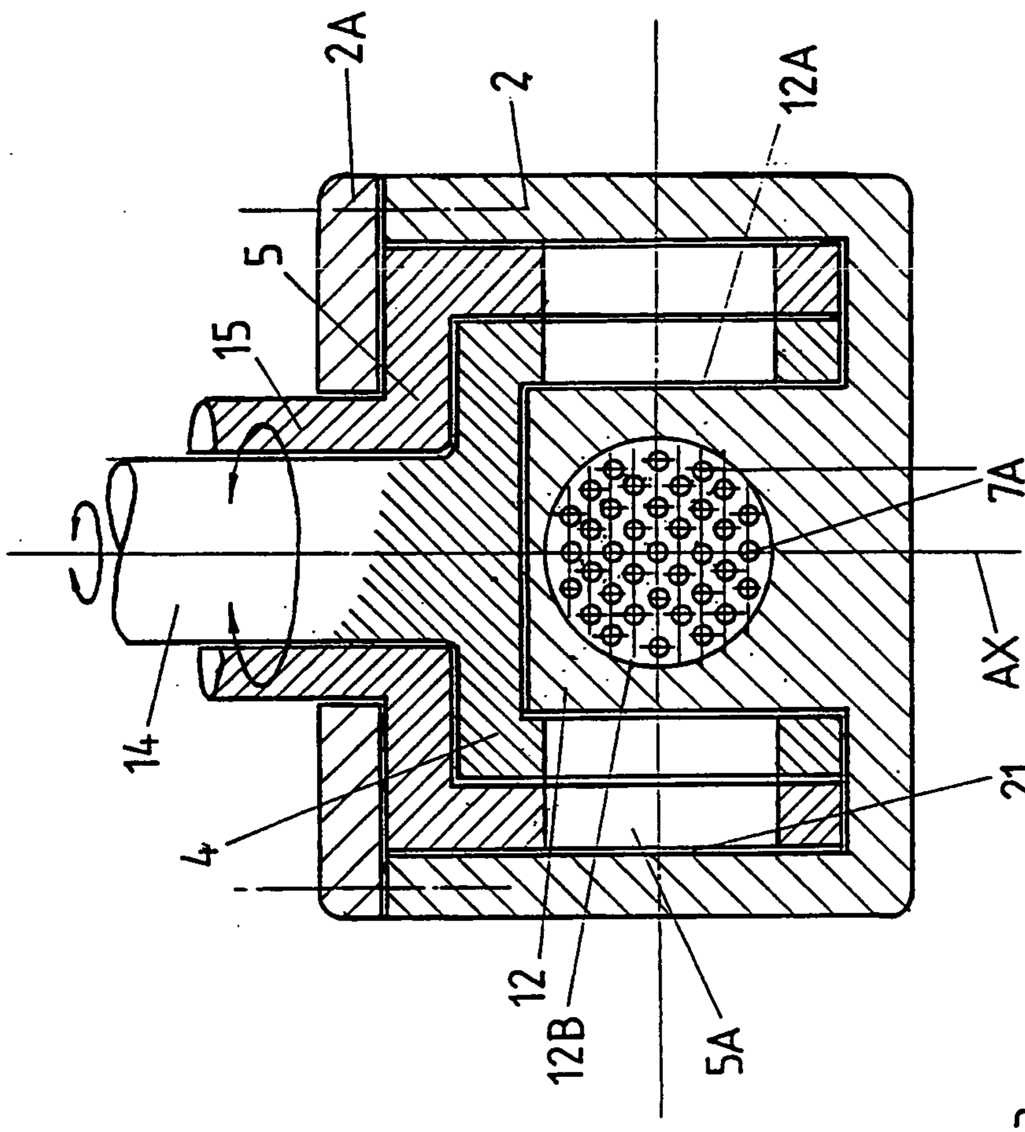

Fig. 3

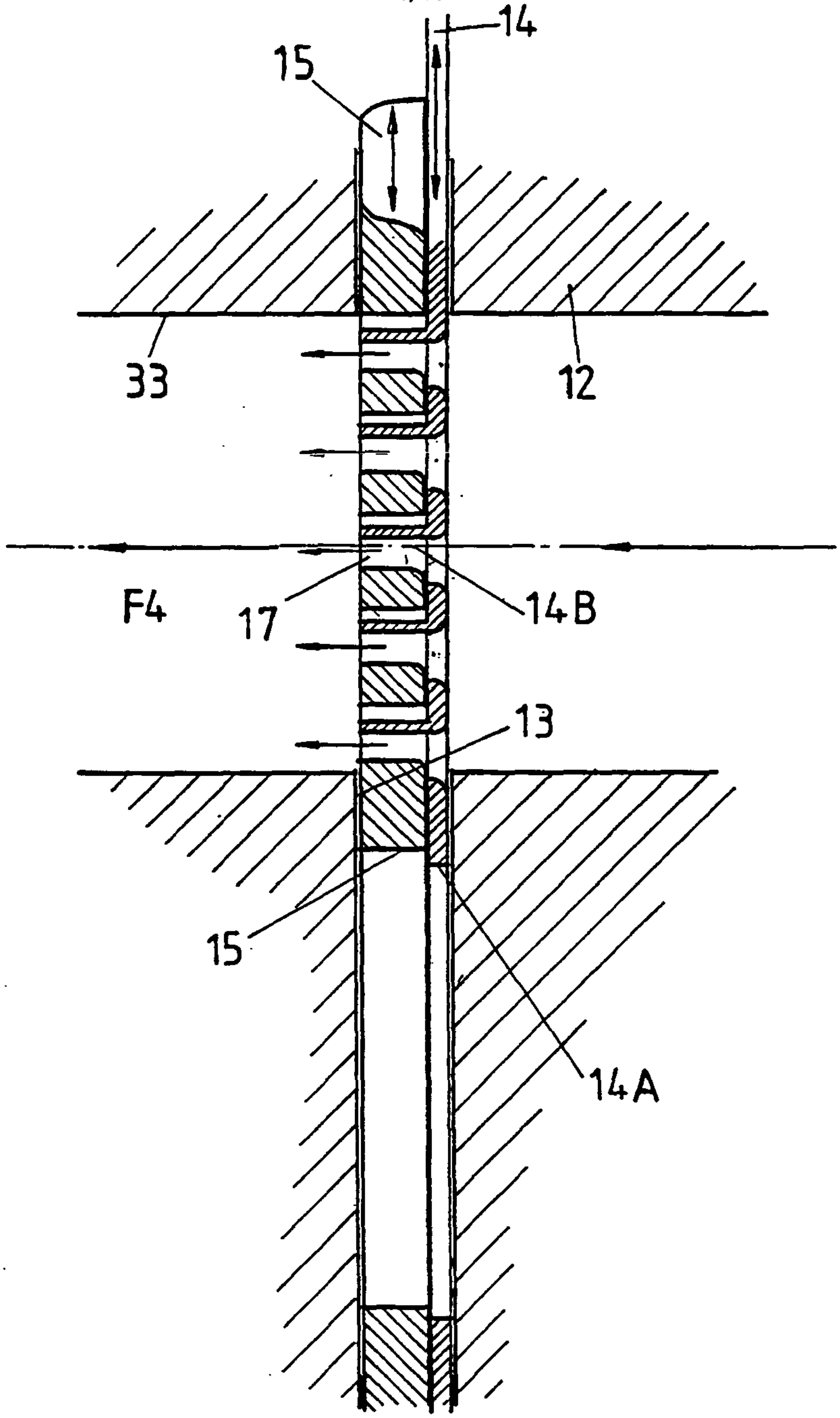

Fig. 4

SUBSTITUTE SHEET

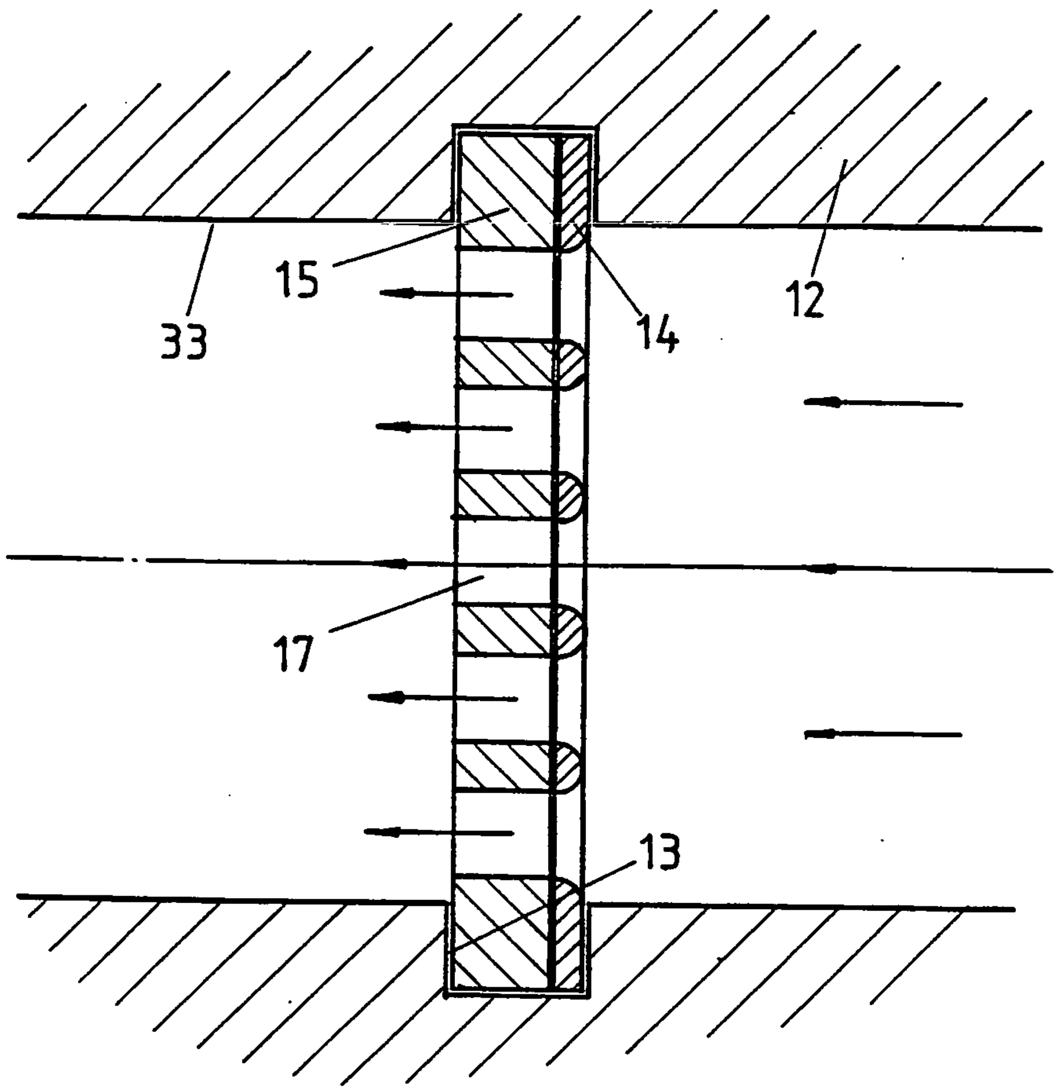

Fig. 5

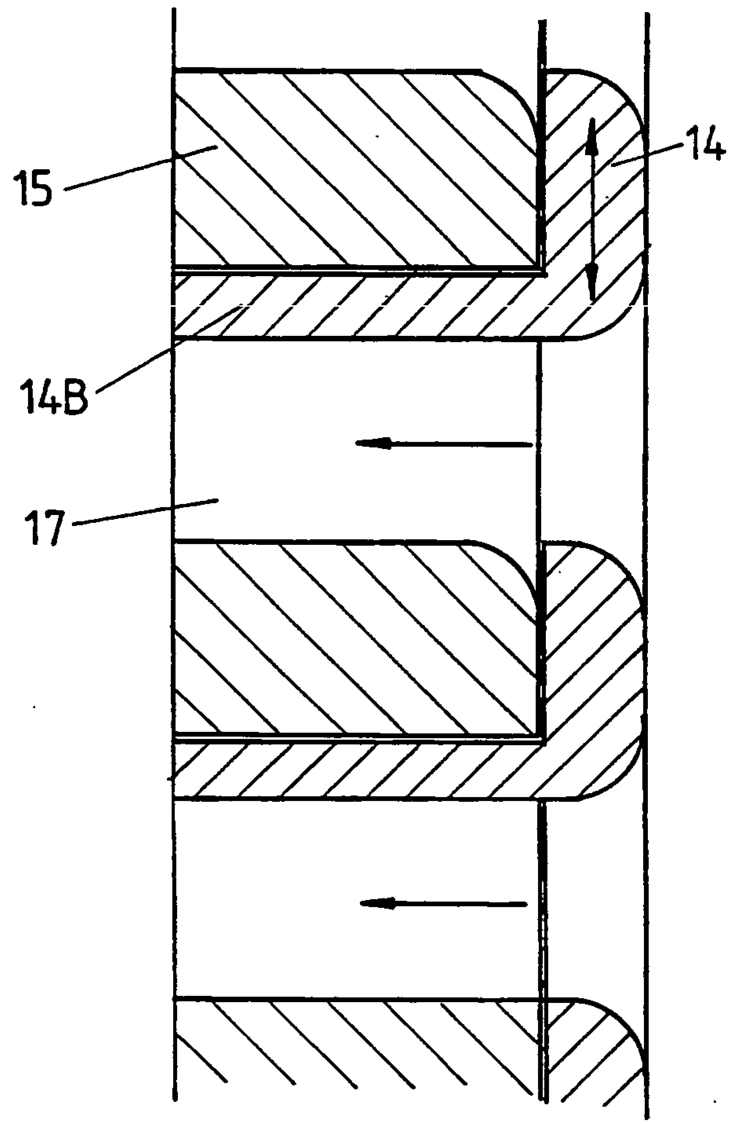

Fig. 6

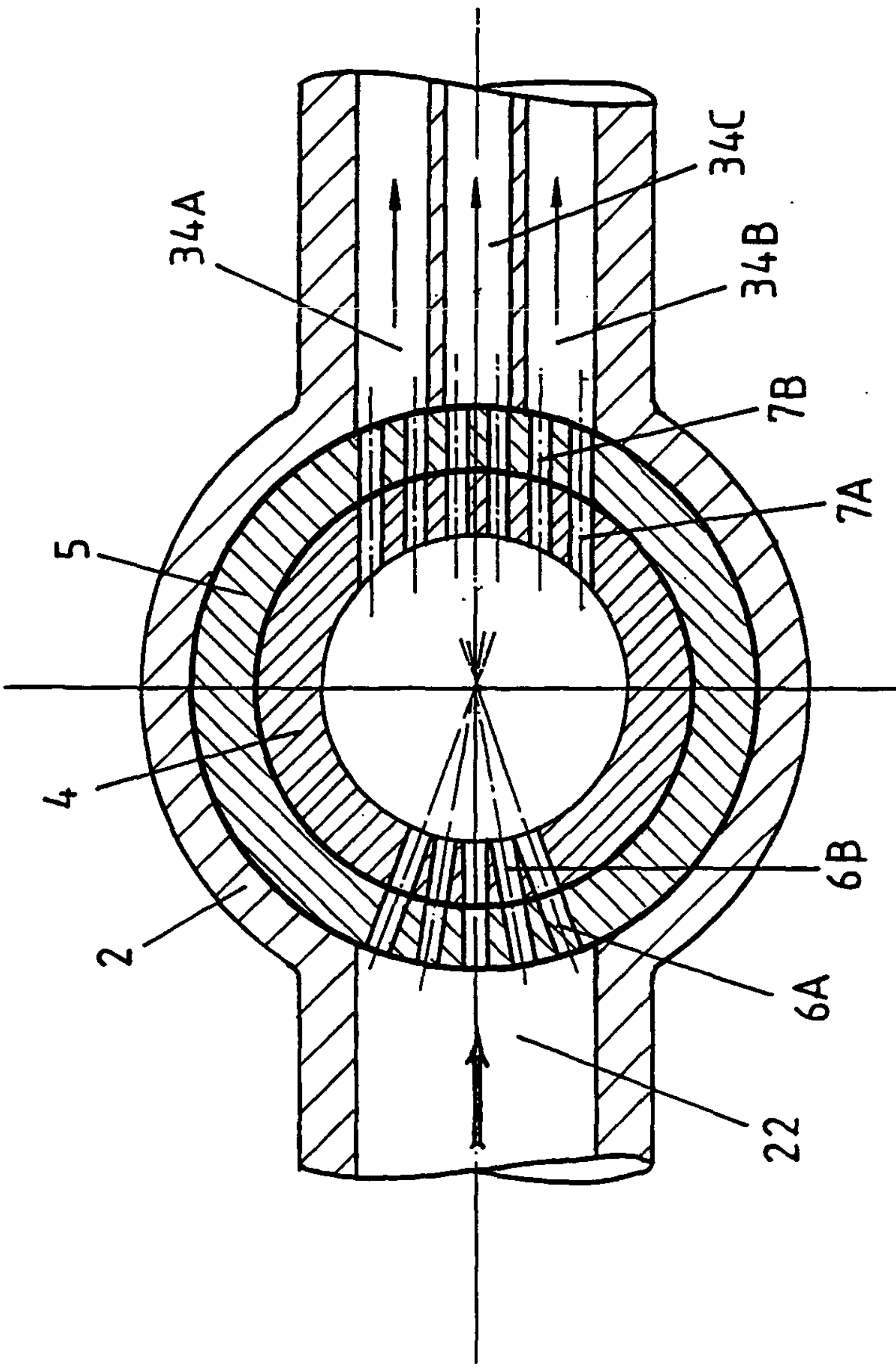

Fig. 7

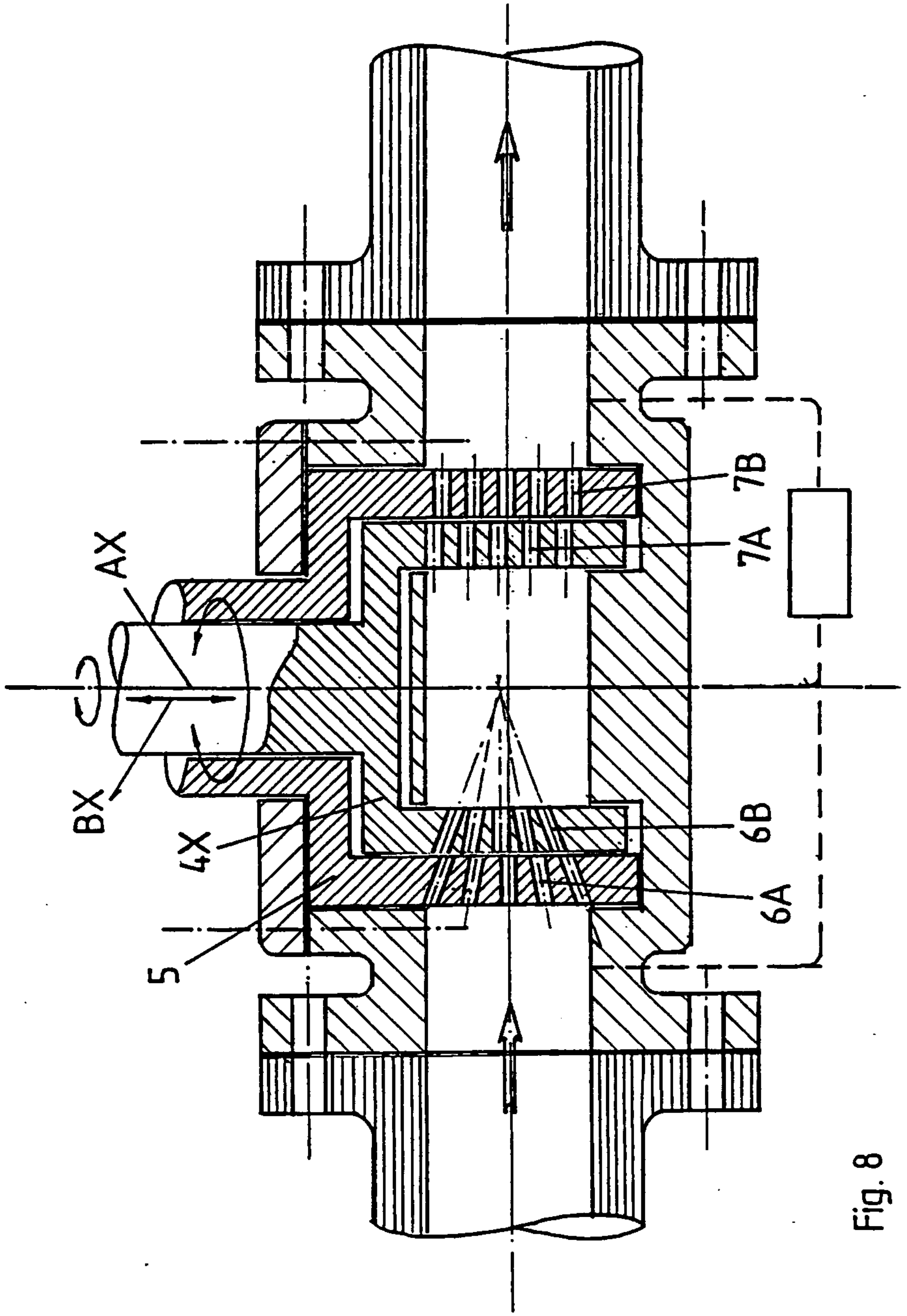

Fig. 8

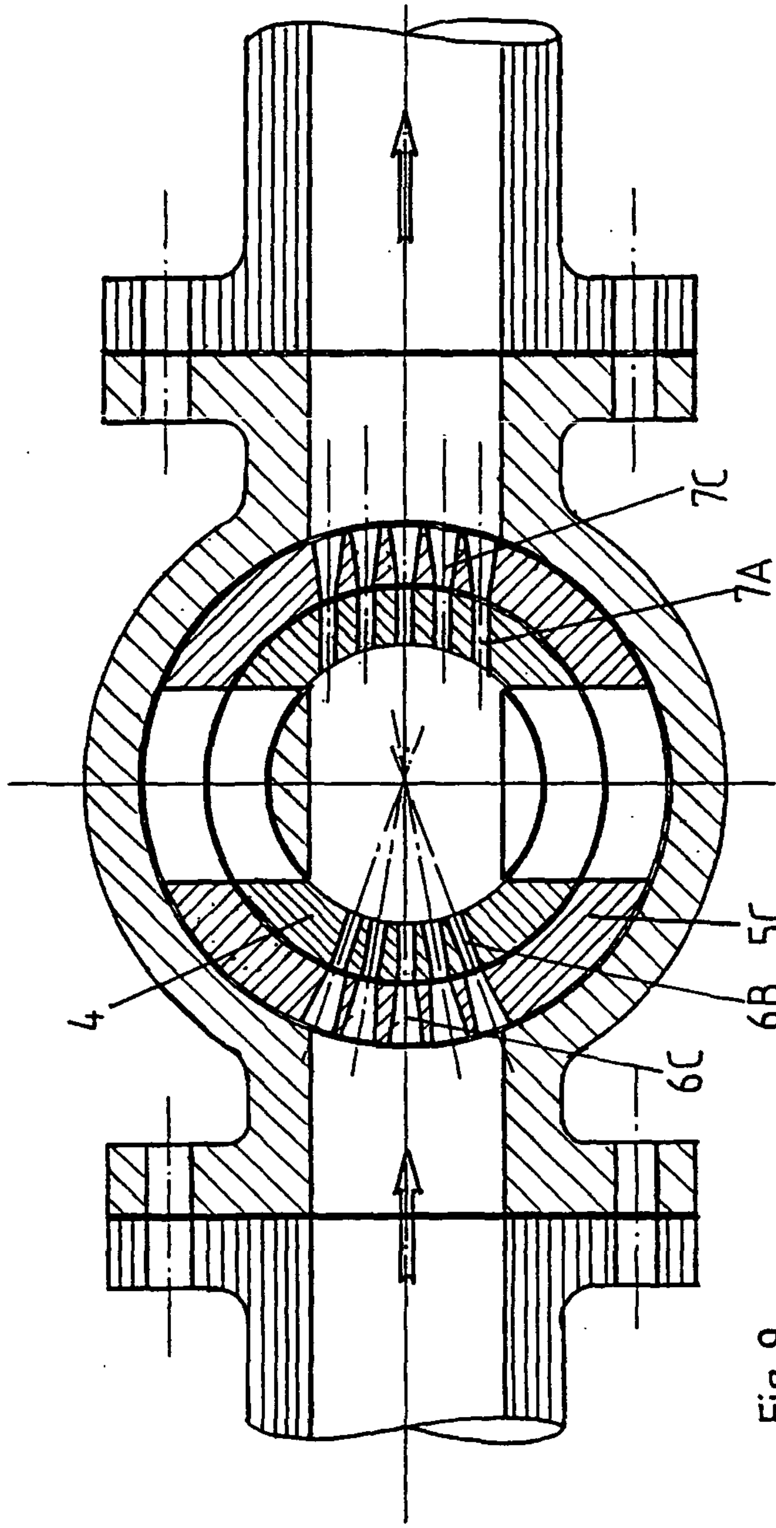

Fig. 9

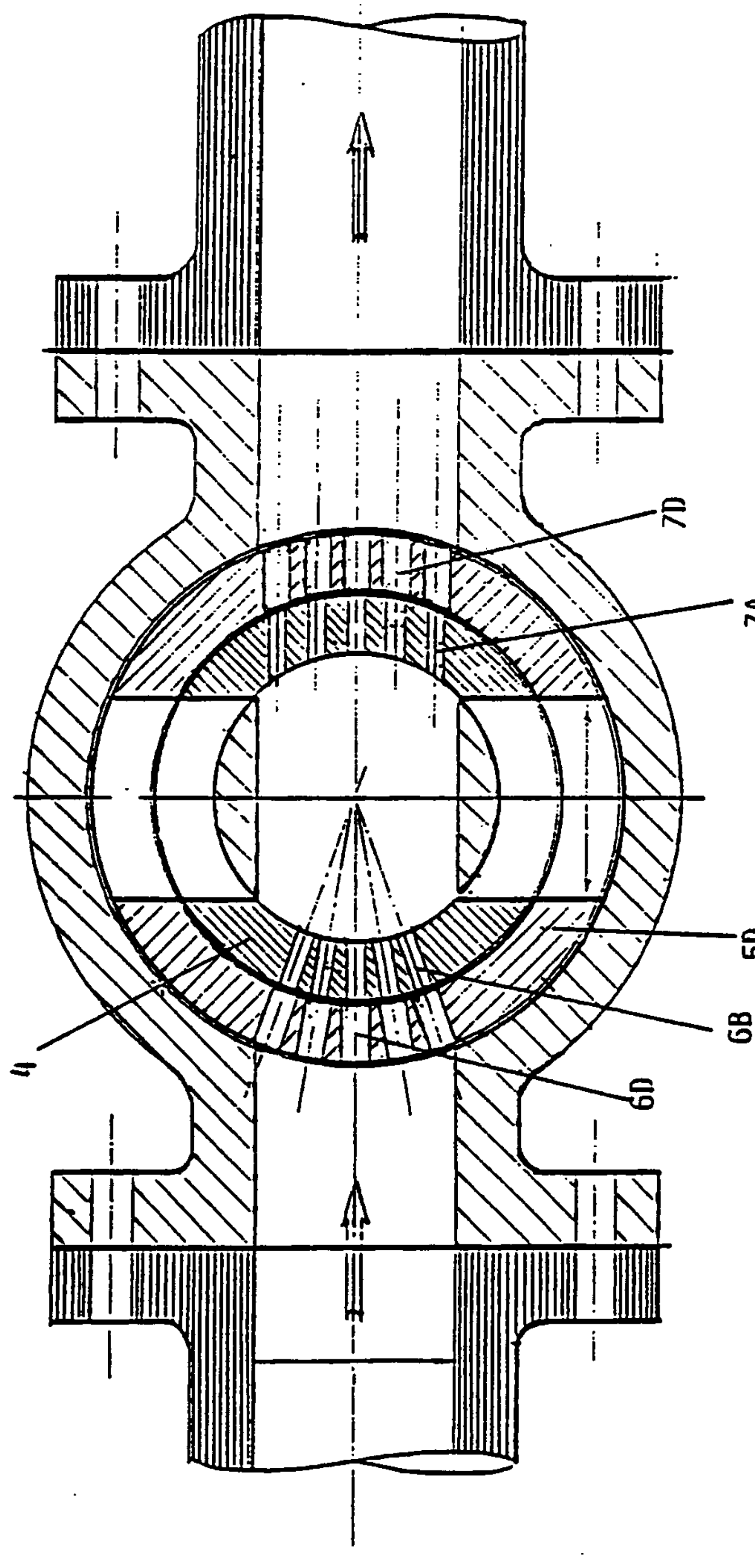

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 94/00125

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01F 5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01F, F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A1, 0489211 (NORAM ENGINEERING & CONSTRUCTORS LTD.), 10 June 1992 (10.06.92), column 3, line 32 - line 48, figures 1,2	1
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A	SE, B, 449031 (AB TORE J HEDBÄCK), 30 March 1987 (30.03.87), figure 1, abstract	1
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" erlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 October 1994	31 -10- 1994
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Wiva Asplund Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/10/94

International application No.
PCT/NO 94/00125

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A1- 0489211	10/06/92	US-A- 4994242	19/02/91
		CA-A- 2036174	13/08/92
SE-B- 449031	30/03/87	SE-A- 8503705	06/02/87
		WO-A- 8805880	11/08/88